Space Weather Technical Forecast

Issued on Tuesday, 15 February 2022 at 00:42 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of Minor R1 Radio Blackouts. Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity rose to Moderate in the UTC day of Monday 14 February, with an M1.0 flare observed from the largest and most magnetically complex region on the sun at 14/1731UTC. This was a long-period event and likely produced a Coronal Mass Ejection (CME) - this will be analysed once coronagraph imagery becomes available, although it is in a marginal location to have any impact at Earth.

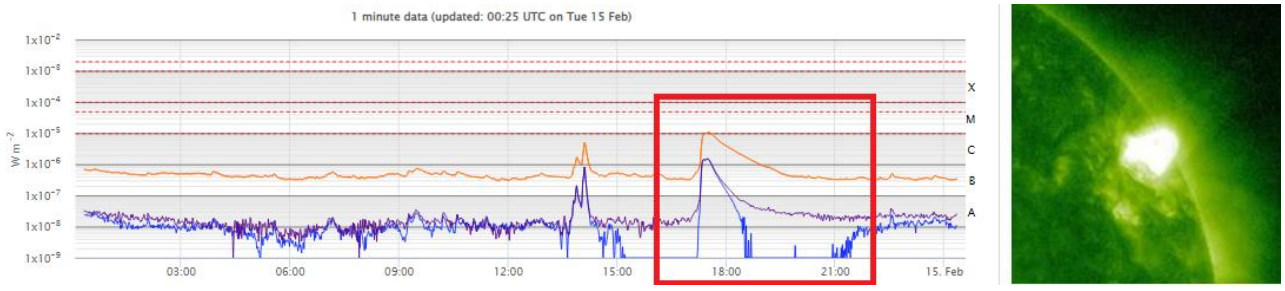

Figure 0: GOES 16 X-ray flux and AIA 094 imagery showing the M1.0 flare from AR2941 peaking 14/1731UTC.

The sunspot responsible is a long-term resident, AR2941, which underwent some proliferation in its intermediate spots in the period as well as areal growth, finishing the 24 hours as an Fai/Beta-Gamma. The precise class of this group is becoming difficult to ascertain owing to its westward position. There were up to four other sunspot regions on the disc: Active Regions 2948, 2943 and 2947 were all relatively simple bipolar groups, although all with a slight growth trend, most marked in 2943, which re-emerged from plage. This left 2946 as a simple unipolar group in the eastern solar hemisphere, with no notable changes observed.

No CMEs were in evidence in available coronagraph imagery in the 24 hours.

Solar Wind / Geomagnetic Activity: Earth is currently undergoing a gradual exit from a high speed stream from coronal hole 53, with the solar wind speed, as measured DSCOVR at L1, falling from a high of near 525km/s to reach near 425 by the period's end. The solar wind density also showed a slight decline, from around 10ppcc at peak, finally falling to mid-single figures. The IMF was small in scale, peaking at just 5nT, while the north-south component ranged from +4 to -5nT. The phi angle, meanwhile was predominantly negative (towards the sun).

The net result of the above solar wind measures was provisionally Quiet to Unsettled geomagnetic activity, with a downward trend evident from an early peak of Kp 3- in the 00-03UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV)

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measured at GOES 16 was at Background levels.

The high energy electron flux (greater than 2MeV) ranged from Moderate to High levels, peaking at 5480pfu at 14/1835UTC. The corresponding 24-hour integrated electron fluence was above the1e8 Active level throughout, with a rising trend observed, that finished the period at 14/2359UTC with 2.31e8 integrated pfu.

Four-Day Space Weather Forecast Summary

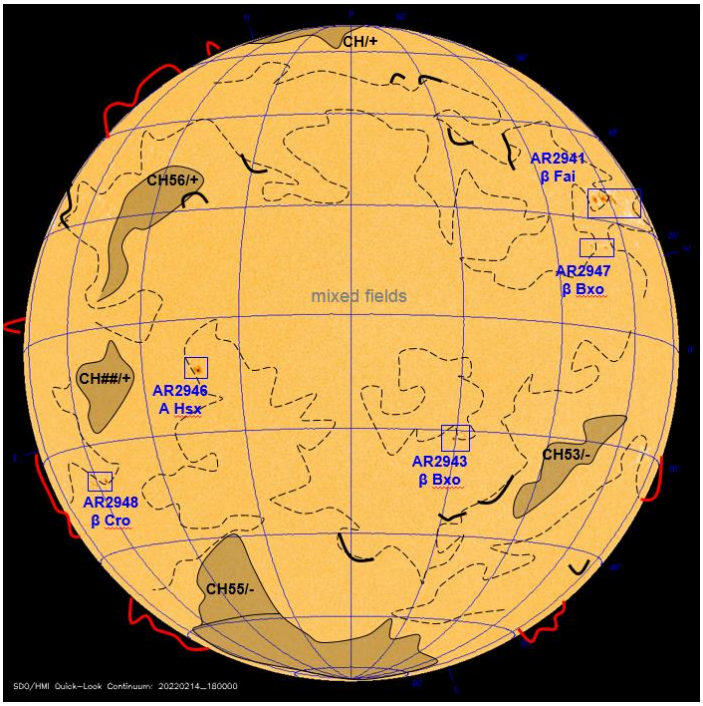
Solar Activity: Solar activity is forecast to carry a daily Chance (30%) of M-class flares - these most likely from AR2941 until midweek, at which point this risk should then fall, with activity becoming Low or Very Low.

Solar Wind / Geomagnetic Activity: No CMEs feature in this forecast period. The only coronal hole in the forecast period is currently geoeffective, and activity is considered very likely to have peaked, meaning occasional Unsettled activity before midweek should return to Quiet by the end of the four days.

Energetic Particles / Solar Radiation: High energy proton flux is most likely to remain at Background levels, but with a daily Slight Chance of S1, mainly up to and including midweek while AR2941 remains on the front side.

The high energy electron flux is expected to continue in its current mainly High flux diurnal oscillation - in the absence of any further drivers of increased geomagnetism. Active (1e8 integrated pfu) electron fluence levels are expected each day, perhaps with a slight waning trend as the ambient environment proves less supportive of maintaining current levels with time.

Figure 1. Solar Analysis Valid 14/1800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No CMEs feature in this forecast at present, however confidence in this is somewhat lower than usual given numerous (particularly westward-directed) CMEs observed around the very end of the last week.

The only coronal hole due in the coming four days is the now assumed long-peaked CH53, with an ongoing gradual exit and reduction in geomagnetism expected over the four days. Occasional Unsettled intervals should become unlikely after midweek, whereupon a mostly Quiet regime should be restored. This forecast is reflected in both persistence, the appearance of the current disc (i.e. the absence of notable central coronal holes) and also unremarkable recent STEREO A measurements.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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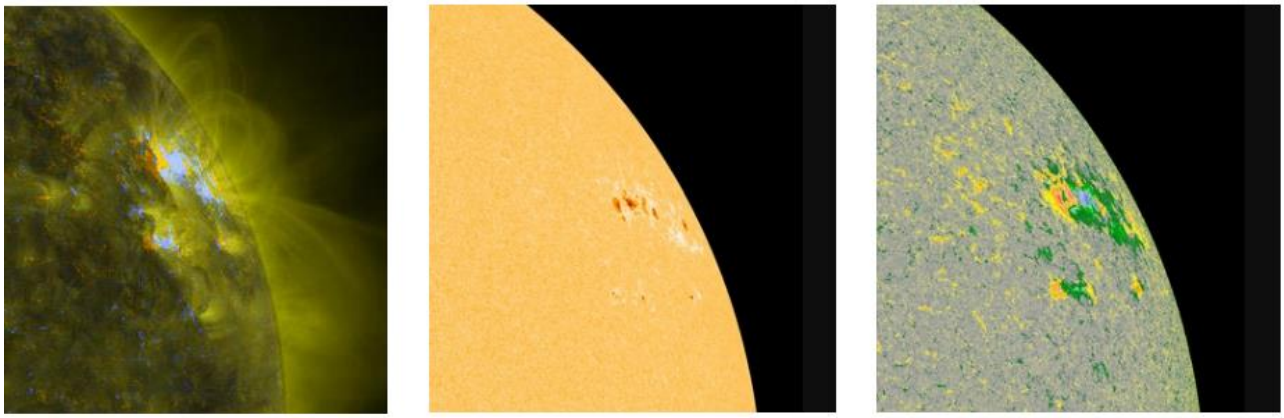
Radio Blackouts - X-Ray Flares:

The balance of sunspot groups should enter a state of flux over the forecast period. Returning regions Ex-2935 and Ex-2934 should begin to rotate onto the visible disc, with both appearing on far-side soundings and EUV imagery. This is in contrast to the depopulation expected to occur of the current western limb. This is all happening in the context of a changing disc, with flaring being observed from sources beyond the west limb as well as AR2941.

The X-ray forecast on balance starts with a daily Chance of M-class flares, reducing to a Slight Chance after midweek, however this may be revised further downwards should the eastern horizon spots fall short of expectations as the western limb quietens down.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	30	30	20	5
Very Active	R3 to R5 X Class	No	2	2	2	1

Figure 2: 15/0000UTC imagery of AR2941, progenitor of the M1.0 flare and the largest and most complex region on the disc. Shown are (left to right): AIA 171 and HMIBC composite image; HMIIF and HMIBC. This group is suggested as a Fai/Beta-Gamma, although the viewing angle is narrowing which is hampering analysis.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux, as measured by GOES-16 is at background levels.

Solar radiation storms are not expected in the period, however there is a very slight chance for proton fluxes to rise given any significant flaring from regions close to the western limb, mainly up to and including midweek while AR2941 remains on the front side.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

Earth remains under the influence of CH53/-, with high energy electrons now having responded by rising to a mostly High flux diurnal oscillation. In the absence of any further impetus in the four-day period, current levels should be maintained initially, but with increasing uncertainty with time and perhaps a gradual ebb.

Current levels are proving similar to the last rotation, where the Active 24-hour integrated fluence threshold was marginally exceeded each day. This gives us greater than usual confidence that Active fluence levels are expected in the four-day period, with REFM likely providing a good guide to fluence trends.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	80	70	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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Figure 3: Top: GOES 16 electron flux over the past 27 days, showing a similar response to last rotation given a similar magnitude coronal hole (600km/s CH53/-); Middle: observed 24-hour integrated fluence on last pass for subsequent four days; current REFM forecast and observed fluence levels – i.e. similar in level to 27 days ago.

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